Citation 1

(19) Canadian Intellectual Property Office

An Agency of Industry Canada

Office de la Propriété Intellectuelle du Canada

Un organisme d'Industrie Canada

(11) CA 2 324 315 (13) A1

(40) 16.03.2000
(43) 16.03.2000

(12)

(21) 2 324 315

(22) 30.08.1999

(51) Int. Cl.[7]: G01M 1/04

(85) 18.09.2000

(86) PCT/EP99/06372

(87) WO00/14503

(30) 198 39 976.6 DE 02.09.1998
198 44 975.5 DE 30.09.1998

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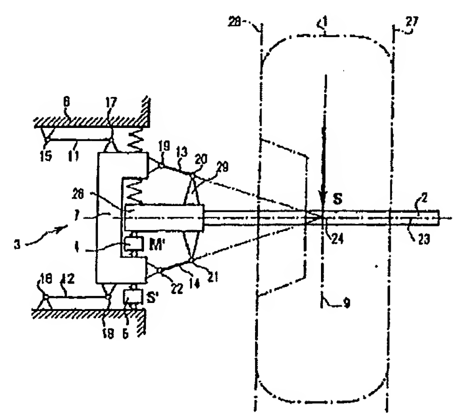
(54) DISPOSITIF POUR MESURER DES FORCES PRODUITES PAR UN DEFAUT D'EQUILIBRAGE D'UN ROTOR
(54) DEVICE FOR MEASURING THE FORCES GENERATED BY A ROTOR IMBALANCE

(57) The invention relates to a device for measuring the forces which are generated by the imbalance of a rotor (1), especially of an automobile wheel. The device comprises a measuring shaft (2) which is mounted in such a way that it can rotate about its axis (23) and to which the rotor (1) is fixed in order to carry out the measurement, and a mounting arrangement (3) for mounting the measuring shaft (2) on a stationary frame (6). The mounting (3) has dynamometers (4, 5) and an intermediate frame (7) on which the measuring shaft (2) is supported by a first dynamometer (4) and at least one virtual bearing (24). The intermediate frame (7) is supported on the stationary frame (6) by another dynamometer (5). This results in reduced forced dynamics compared to conventional machines with a floating mounting.



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CANADIAN INTELLECTUAL PROPERTY OFFICE

(12) (19) (CA) **Demande-Application**

(21) (A1) **2,324,315**
(86) 1999/08/30
(87) 2000/03/16

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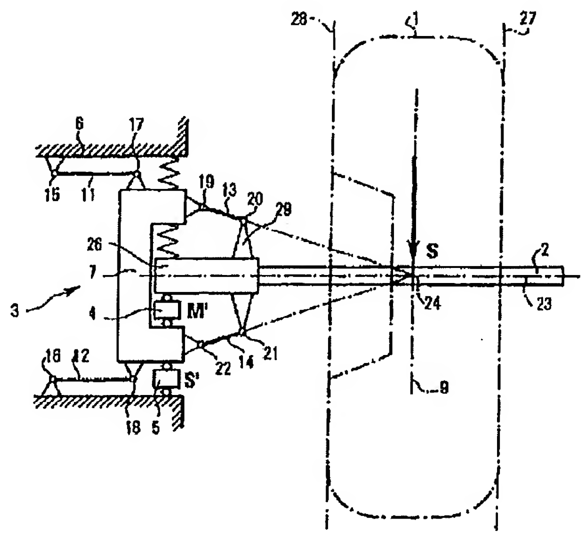
(51) Int.Cl.[7] G01M 1/04
(30) 1998/09/02 (198 39 976.6) DE
(30) 1998/09/30 (198 44 975.5) DE

(54) **DISPOSITIF POUR MESURER DES FORCES PRODUITES PAR UN DEFAUT D'EQUILIBRAGE D'UN ROTOR**

(54) **DEVICE FOR MEASURING THE FORCES GENERATED BY A ROTOR IMBALANCE**



(57) L'invention concerne un dispositif pour mesurer des forces produites par un défaut d'équilibrage d'un rotor (1), notamment d'une roue de véhicule. Ce dispositif comprend un arbre de mesure (2) monté de manière à pouvoir tourner autour de son axe (23) et sur lequel le rotor (1) est fixé pour la mesure, ainsi qu'un ensemble paliers (3) pour le montage de l'arbre de mesure (2) sur un cadre fixe (6), ledit ensemble paliers (3) présentant des dynamomètres (4, 5) et un cadre intermédiaire (7) sur lequel l'arbre de mesure (2) prend appui par l'intermédiaire d'un premier dynamomètre (4) et d'au moins un point d'appui virtuel (24). Le cadre intermédiaire (7) prend appui sur le cadre fixe (6) par l'intermédiaire d'un autre dynamomètre. Cette configuration permet d'obtenir une dynamique des forces réduite par rapport aux machines classiques à montage flottant.

(57) The invention relates to a device for measuring the forces which are generated by the imbalance of a rotor (1), especially of an automobile wheel. The device comprises a measuring shaft (2) which is mounted in such a way that it can rotate about its axis (23) and to which the rotor (1) is fixed in order to carry out the measurement, and a mounting arrangement (3) for mounting the measuring shaft (2) on a stationary frame (6). The mounting (3) has dynamometers (4, 5) and an intermediate frame (7) on which the measuring shaft (2) is supported by a first dynamometer (4) and at least one virtual bearing (24). The intermediate frame (7) is supported on the stationary frame (6) by another dynamometer (5). This results in reduced forced dynamics compared to conventional machines with a floating mounting.

[Summary]

A device for measuring forces that are generated by an unbalance of a rotor 1, in particular a motor vehicle wheel, with a measuring shaft 2 mounted rotating on its axis 23, to which the rotor 1 for measuring is attached, and a mounting 3 - displaying a force sensor 4, 5 - of the measuring shaft 2 on a stationary frame 6 wherein the mounting 3 has an intermediate frame 7 against which the measuring shaft 2 is supported via a first force sensor 4 and at least one virtual mounting position 24 and the intermediate frame 7 is supported on the stationary frame 6 via a further force sensor 5. In this way, reduced force dynamics compared to conventional machines with floating mounting.

(Figure 5)

DEVICE FOR MEASURING FORCES THAT ARE GENERATED BY AN UNBALANCE OF A ROTOR

[State of the Art]

The invention relates to a device according to the introductory clause of patent claim 1, as is known from DE 33 32 978 A1.

With such a device for measuring forces that are generated by an unbalance of a rotor, it is known to mount the measuring shaft rotating in two bearing units arranged at an axial distance from each other and supported via force sensors opposite a hollow bearing housing. This measuring shaft mounting is borne by a stationary frame.

From EP 0 343 265 A1 it is known, in the case of a balancing machine, to mount a backing girder - extending axially to the measuring shaft - pivoting with respect to a stationary frame and to arrange sensors, arranged at an axial distance from each other, between the backing gird and the stationary frame. From DE 33 30 880 A1 it is known to support on a stationary frame a support - receiving the measuring shaft rotary mounting - via force transmitters arranged at an axial distance from each other

In a device known from EP 0 133 229 A1 used for balancing motor vehicle wheels, the measuring shaft is supported on a stationary frame in a mounting that has a force transmitter. To achieve a dynamic balancing, two mounting planes in which the force transmitters are also arranged are provided for the mounting of the measuring shaft.

From EP 0 058 860 B1 a balancing machine for rotary bodies is known in which the measuring shaft is mounted rotating on an elastically flexible flat part arranged vertically on the machine bed. For this, the rotary mounting of the measuring shaft is provided at the upper edge of the flat part. Position excursions of the flat part are detected via an arm of sensors running at right angles to the flat part; the sensors' force initiators run perpendicular to each other. In this connection, one of the sensors records the static portion while the other sensor detects the forces resulting from the dynamic unbalance and causing a twisting of the vertical, elastically flexible flat part around a center line, for example.

Furthermore, from DE-AS 16 98 164 an oscillation-measuring (supercritical) measuring system is known with a mounting for the rotor on leaf springs positioned diagonally to each other and whose extensions form a virtual intersection in one of the balancing planes of the rotor to be balanced. The two leaf springs positioned diagonally to each other are supported against a base plate via an intermediate plate on vertically standing leaf springs arranged parallel to each other. By means of oscillation transformers the vibrations of the leaf springs resulting from a rotor unbalance are detected and converted into corresponding measuring signals.

From DE-AS 10 27 427 and DE-AS 10 44 531 it is known, in the case of spring bars or plate springs that form oscillatory mountings in balancing machines, to form joints by thinning points.

The force sensors provided in known devices in the mounting planes at the measuring points supply sensor signals that are proportional to the centrifugal forces that result from the rotor unbalance and bring about the reaction forces measured by the sensors. With the conventional standard measuring systems for wheel balancing machines, a floating mounting is typical for the measuring shaft and the rotor clamped onto it. Translation onto the two balancing planes on the rotor for the dynamic balancing of the unbalance takes place based on the force lever law of statics. The forces measured in the two mounting planes by the sensors are thus independent of the respective distance of the rotor from the two sensors. Since these distances are different, a superproportional error in the balancing masses calculated for the respective balancing planes when the sensitivity of one of the two measuring converters is modified due to different influences, e.g. due to temperature, ageing, impact, overload, shaking in transport, humidity influence and the like.

[Technical problem of the invention]

The technical problem of the invention is to produce a device of the type mentioned in the beginning in which, due to the above-mentioned force dynamics a sensitivity modification of a measuring converter only slightly affects the mass balancing to be carried out in the balancing planes, e.g. by balancing weights to be attached.

This technical problem is solved according to the invention by the characterizing features of patent claim 1.

For this, the rigidly designed intermediate frame, on which the measuring shaft is supported in a mounting plane displaying a force sensor, is supported on the stationary frame via a further force sensor. The two force sensors are thus situated in two mounting systems for a force-measuring unbalance detection, with each force sensor assigned to one of the two mounting systems. The two mounting systems are situated between the measuring shaft and the rigid frame, e.g., the balancing machine, on which the unbalance measurement is carried out on a motor vehicle wheel. In this connection, the force sensors may be situated in different mounting planes nevertheless situated in the area of the rigid intermediate frame, or in a common mounting plane.

With the design of the two above-mentioned mounting systems, at least one more support of the measuring shaft is provided for that has the property of a virtual mounting position in a further mounting plane. Two such mounting planes with such virtual mounting positions can also be provided for. The virtual mounting positions may be situated on both sides of the rotor to be measured. It is also possible, however, to provide for only one additional mounting plane having a virtual mounting position; this plane being situated preferably between the two balancing planes of the rotor or also between the planes in which the force sensors are situated, and the rotor.

The two force sensors are preferably arranged in a common mounting plane that runs perpendicular to the axis of the measuring shaft. The forces initiated in the force sensors as reaction forces are oriented parallel, particularly coaxially to each other and are situated in the common mounting plane. The force sensors may be situated in the area of the axial extension of the intermediate space in different mounting planes.

A preferred form of construction consists in that the measuring shaft is supported on the intermediate frame in a first mounting plane displaying a force sensor and in a second mounting plane displaying the virtual support point and that the intermediate frame in the one mounting plane is supported against the stationary frame via the second force sensor and, furthermore, is linked to the stationary frame by means of a parallel guide. The mounting plane displaying the

virtual support point can be situated between the rotor, particularly a motor vehicle wheel, and the mounting plane that has the two force sensors, or preferably between the two balancing planes of the rotor, particularly a motor vehicle wheel.

The intermediate frame can be supported via a pair of support levers and joints at the respective ends of the support lever. The measuring shaft can also be supported via a pair of support levers and joints at the lever ends on the intermediate frame. The axes of the respective joints run perpendicular to the plane in which the forces introduced into the force sensors and the axis of the measuring shaft are situated. The pair of support levers supporting the intermediate space on the stationary frame can provide at the same time the parallel guide of the intermediate space. For this, the support levers run parallel to each other. It is also possible, however, to arrange the support levers at an angle to each other, with the apex of the angle preferably situated in the axis of the measuring shaft or in the vicinity of this measuring shaft axis. The joints of the support lever are then supported in the corners of a trapezoid of the layout of the support levers. With this arrangement, the virtual mounting position situated on the outer side of the rotor is created. The virtual mounting position - support inside the rotor, particularly between the balancing planes - can also be formed by support levers arranged at an angle to each other and whose joints are supported in the corners of a horizontal trapezoid of the support lever arrangement. The support levers are preferably formed as rigid flat parts, e.g.., sheet metal parts, cast parts, rolled flat parts and the like which ensure along with the joints that the desired force e.g. running essentially linearly and axially, is introduced into the sensors. The support lever arrangement formed from the flat parts can be designed in one piece, wherein the flat parts are designed rigid and only the joints situated in between and running essentially linearly are flexible. The joints can be formed by weak points, e.g. constrictions between the individual flexible flat parts. In this way, flexible joint axes are formed between the flexible flat parts. With the corresponding arrangement, parallel or at an angle, the desired virtual mounting positions that are formed in the respective linearly extending mounting axes are then created, as explained above.

The virtual mounting positions are also the measuring points taken into account in the frame calculator of the balancing machine and representing virtual measuring points.

(Examples)

By means of the figures, the invention is explained in greater detail in examples of execution. The following are shown:

Fig. 1: a first example of execution;

Fig. 2: a second example of execution;

Fig. 3: a third example of execution;

Fig. 4: a fourth example of execution;

Fig. 5: a fifth example of execution;

Fig. 6: a sixth example of execution;

Fig. 7: a top view of a measuring arrangement and mounting for the measuring shaft, as may be used in the forms of construction of Figs. 1, 3 and 5;

Fig. 8: a perspective view of the measuring arrangement of Fig. 7 seen from the front to the back

Fig. 9: a perspective illustration of the measuring arrangement of Figs. 7 and 8 seen from above and from the side; and

Fig. 10: a seventh example of execution.

A rotor 1 is shown in a schematic diagram in the figures; it is attached for unbalance measuring to the measuring shaft 2 in known manner by clamping means not illustrated in any further detail. The measuring shaft 2 is mounted rotating on a stationary frame 6. This can be the machine frame of a wheel balancing machine. Mounting is by means of a mounting 3 yet to be described in detail, that also has force sensors 4, 5. The mounting 3 may have a tubular rotating bearing 26 in which the measuring shaft 2 is mounted rotating. The rotary bearing 26 that receives the measuring shaft 2 is rigidly mounted in a first mounting plane 8b on an intermediate frame 7 over the sensors 4. In addition, a virtual support point 24 is created in

another mounting plane 9 by support levers 13, 14 that form a support lever pair and run at an angle to each other. The support point 24 acts like a swivel pin that runs perpendicular to the direction of force introduction of the reaction forces resulting from the unbalance measurement into the sensors 4. At their ends, the support levers 13 and 14 are connected flexibly (joints 19 and 22) with the intermediate frame 7 and flexibly (joints 20, 21) with the rotating bearing 26 for the measuring shaft 2. The joint axes of the joints 19 through 22 run parallel to the swivel pin that is formed in the virtual mounting position 24. The virtual mounting position 24 can be situated between the rotor 1 and the mounting plane 8 in which the force sensors 4 and 5 are situated (Fig. 1 and 2). The virtual mounting position 24 may also be situated in the area of the rotor, however, particularly between the balancing planes 27, 28 in which the unbalance is balanced, for example by attaching balancing weights (Fig. 5 and 6).

The intermediate frame 7 is supported on the stationary frame 6 via the force sensor 5. The force sensor 5 may be arranged in the mounting plane 8 situated perpendicular to the measuring shaft 2. It is also possible, however, to arrange the force sensor 5 in another mounting plane, shifted in the axial direction of the measuring shaft 2. Furthermore, the intermediate frame 7 is supported via a pair of support levers (support levers 11 and 12) on the stationary frame 6. At the ends, the support levers 11, 12 are connected flexibly (joints 15, 16) with the stationary frame 6 and flexibly (joints 17, 18 in Figures 1, 3, 5, 10 and 7 through 9 as well as joints 19, 22 in Figures 2, 4 and 6) with the intermediate frame 7. The intermediate frame 7 is designed as a rigid mounting block or rigid, stiff mounting frame.

In the forms of construction of Figures 1 and 2 as well as 5 through 9, the support levers 11 and 12 run essentially parallel to each other and parallel to the axis 23 of the measuring shaft 2. The support levers 11 and 12 thus form a parallel steering guide for the force introduction into the force sensor 5 - directed essentially perpendicular to the axis 23 of the measuring shaft 2 -of the reaction forces resulting during the unbalance measuring process.

In the forms of construction of Figures 3, 4 and 10, the two support levers 11 and 12 are arranged at a sharp angle to each other, the apex of which is situated in the axis 23 of the measuring shaft 2 or in the vicinity of the axis 23. This apex forms a further virtual mounting

position 25 in a mounting plane 10 situated on the outside of the rotor 1 and extending perpendicular to the measuring shaft 2.

In the form of construction of Figure 10 the virtual mounting position 25 and the mounting plane 10 are situated in an extension, indicated by dot-dash, of the measuring shaft 2 that runs - with respect to the mounting 3 of the measuring shaft 2 - opposite the longitudinal extension of the measuring shaft 2. The mounting position 25 and the related mounting plane 10 are situated - with respect to the mounting 3 - on the side opposite the rotor 1.

The virtual mounting position 25 also has the property of a swivel pin that is situated perpendicular to the axis 23 of the measuring shaft 2 and perpendicular to the direction of introduction of the forces into the force sensors 4 and 5. In the illustrated examples of execution, this force introduction takes place in the mounting plane 8. To form the swivel pin property in the respective virtual mounting position 24, 25, the joint axes of the joints 15 through 22 run parallel to each other and perpendicular to the axis 23 of the measuring shaft 2 and to the force introduction direction of the reaction forces into the force sensors 4 and 5 in the mounting plane 8.

In the forms of execution of Figures 3 and 4, on both sides of the rotor 2, namely on the inside and the outside of the rotor, mounting planes 9 and 10 are created with the virtual mounting positions 24 and 25. The virtual mounting positions 24 and 25 have the properties of virtual measuring points. Forces L assigned to the inner mounting position 24 and forces R assigned to the outer mounting position 25 are introduced into the force sensor 4. The force sensors generate corresponding sensor signals L' and R'. That virtual measuring points are also created in the virtual mounting positions 24 and 25 results from the fact that when a centrifugal force resulting from the rotor unbalance engages the left mounting plane 9, a measuring signal L' proportional to the value of this centrifugal force is emitted by the force sensor 5, while the force sensor 4 emits no signal. When the right outer mounting plane 10 is engaged by a centrifugal force R resulting from the rotor unbalance, only the force sensor 4 emits a proportional measuring signal R', while the force sensor 5 generates no signal. This results in a floating mounting in which the balancing planes 27 and 28 are situated on the rotor 1 between the virtual measuring points / virtual measuring planes that concur with the mounting planes 9

and 10, as shown in Figs. 3 and 4. In the case of a force engagement - resulting from the rotor unbalance - between the mounting planes 9 and 10, the mounting forces effective in these planes (virtual measuring planes) are divided up according to the mounting distances from the engagement point and corresponding sensor signals are emitted by the force sensors 4 and 5.

In the forms of construction shown in Figure 10, the one virtual mounting position 24 at which a centrifugal force L resulting from the rotor unbalance can be effective is situated in the mounting plane 9 between the two balancing planes 27, 28, preferably roughly in the middle between the two balancing planes 27, 28. The other virtual mounting position 25 is situated with respect to the mounting 3 of the measuring shaft 2 on the other side in the extension of the measuring shaft. Here a centrifugal force R resulting from the rotor unbalance is active. As already explained above, the sensors 4 and 5 deliver measuring signals R' and L' proportional to the centrifugal forces R and L.

In the forms of construction of Figures 1 and 2 as well as 5 through 9, the outer virtual mounting position is situated at infinity or at a relatively great distance of several meters, e.g., from roughly 3 to 20 m and more, because, due to the support levers 11 and 12, essentially a parallel guide of the intermediate frame 7 is created. If a centrifugal force (L in Figs. 1 and 2 and S in Figs. 5 and 6) resulting from the rotor unbalance is introduced in these forms of construction in the mounting plane 9 (virtual measuring plane) at the virtual mounting position (virtual measuring point), this force is only detected by the force sensor 5 and a proportional signal L' / S' is emitted by it. The force sensor 4 emits no signal. Regardless of the distance of the introduced centrifugal force, the force sensor 5 will only emit a signal proportional to the centrifugal force value due to the parallel guide of the intermediate frame 7. The force sensor 4, on the other hand, will emit a measuring signal M' that is not only proportional to the centrifugal force value and thus to the unbalance value, but also to the distance of the force introduction point of the mounting plane 9 / the virtual mounting position 24.

In the forms of construction of Figures 1, 3, 5 and 10 as well as Figs. 7 through 9, the intermediate frame 7 is supported on the stationary frame 6 with the help of the support lever pair formed by the support levers 11 and 12 and the tubular rotary mounting 26 of the measuring shaft 2 is supported by means of the support lever pair formed by the support levers

13 and 14, one behind the other when observed in axial direction of the measuring shaft 2. The support lever pairs of the forms of construction of Figures 3 and 4 have the same direction of inclination. In the example of execution 11, 12, the direction of inclination is opposite to the direction of inclination of the support lever pair 13, 14. In the forms of construction of Figures 2, 4 and 6, the support frame 7 is supported on the stationary frame 6 and the rotary mounting 26 of the measuring shaft 2 is supported on the intermediate frame 7 with the respective support lever pairs 11, 12 and 13, 14 next to each other / one above the other. In this connection, the joints 17, 19 and 18, 22 can fall together in the common joints 19 and 22 on the intermediate frame 7, as illustrated in Figs. 2, 4 and 6.

The support levers 11 through 14 can be formed by flat parts that are designed rigid and stiff. The flat parts can be formed of one piece, in connection with which the joints are formed by linear weak points, e.g. in the form of constrictions. As can be seen from Figs. 7 through 9, a retaining plate 33 that is a component of the retaining device 29 can also be formed from the piece that forms the flat parts for the support levers 11 through 14. The retaining plate 33 is solidly connected with the tubular rotary mounting 26, for example by welding. In addition, an angle bracket 34 can also be provided as a component of the retaining device 29; it is also solidly connected with the retaining plate 3 and the rotary mounting 26, for example by welding. In the figures, the upper angle bracket 34 is illustrated. A lower angle bracket can also be provided. The upper and lower angle brackets can also consist of an elbow, in which the rotary mounting 26 is connected solidly and in guided manner through an opening in the elbow, e.g., by welding with the elbow. In this way, a rigid, stiff connection of the retaining device 29 with the rotary mounting 26 between the two joints 20 and 21 is created. The joints 20 and 21 are situated between the two support levers 13 and 14 and the retaining plate 33.

From the one piece from which the flat parts for the support levers 11 through 14 are formed, attaching plates 37, 38 and 40, 41 can also be formed. The attaching plates 37, 38 are connected solidly, for example by bolt connections or otherwise, with the stationary frame 6. The attaching plates 37 and 38 form the attaching points for the support lever arm formed from the support levers 11 and 12 and with which the intermediate frame 7 is supported on the stationary frame 6. Between the attaching plates 37 and 38 and the flat parts that form the support levers 11 and

12, the joints 15 and 16 are formed by the linear weak points / constrictions. The weak points have a concave, particularly a semicircular cross-section.

In addition, from the one piece are formed the two attaching plates 40 and 41 that are connected solidly, for example by bolt connections, welding or the like, with side surfaces of the intermediate frame 7. Between the two attaching plates 40 and 41 and the support levers 11 and 12, the joints 17 and 18 are formed by the weak points / constrictions. Between the flat parts that form the support levers 13 and 14, the joints 19 and 22 are formed by weak points / constrictions.

In this way, from a single piece practically the entire mounting 3 is formed with which the measuring shaft 2 is supported on the stationary frame 6 and which predetermines the virtual mounting positions and measuring points.

The parallel guiding of the intermediate frame 7 on the stationary frame results essentially from the fact that the outlines of the concave constrictions 15, 17 and 16, 18 are situated on both sides of the support levers 11 and 12 roughly in parallel planes 35 and 36, in which the guiding function of the two support levers 11 and 12 is achieved. The respective constrictions 15, 17 and 16, 18 are situated on opposite surfaces of the support levers 11 and 12 forming the flat parts. The support levers 11 and 12 are inclined toward each other at an extremely sharp angle, in connection with which, however, as already explained, the parallel steering guide is achieved by a guiding function in the parallel planes 35 and 36. In this way, measuring arrangements corresponding to Figures 1 and 5 can be achieved. In order to achieve a measuring arrangement corresponding to Figure 3, the support levers 11 and 12 can be inclined toward each other at a correspondingly wider angle.

In order to implement the example of execution illustrated in Figure 10, the support levers 11, 12 in Figures 7 through 9 are oriented toward each other at their rear ends. The rear constrictions / joints 15, 16 are situated more closely to the axis of the measuring shaft 2 than the front constrictions / joints 17, 18.

As Fig. 8 also shows, the two force sensors 4, 5 are arranged in a reference line, with the force sensor 4 arranged between the rotary mounting 6 and the inside of the intermediate frame 7 and

the force sensor 5 between the outside of the intermediate frame 7 / the attaching plate 41 (Fig. 9) and the stationary frame 6.

For the drive of the measuring shaft 2, an electric motor 30 is provided that drives the measuring shaft via a belt drive 31. The motor 30 is mounted on the rotary mounting 26 via an extension arm. With this mounting, the measuring result is not affected by disturbances resulting from the motor drive.

Observed in axial direction, a compact mounting 3 for the measuring shaft 2 on the stationary frame 6 is created. This results - in connection with the reduced force dynamics, particularly with a floating mounting of the measuring shaft 2 - in a reduction of the influence of changes in sensitivity of the force recorders, for example as a result of different effects of temperature, ageing, impact, overloading, shaking during transport and humidity, a reduced need to replace the force sensors, for readjustments of the measuring arrangement after transport and setup of the machine, reduced service costs, improved measuring precision, reduced demands on the resolution of the AD-converters during digitalization of the analog measuring signals and a greater virtual distance of the measuring planes in spite of the compact construction. Despite the stationary mounting of the measuring shaft, reduced force dynamics are achieved similar to those of a measuring arrangement with two mounting positions on both sides of the rotor.

[Reference number list]

1	rotor
2	measuring shaft
3	mounting
4	force sensor
5	force sensor
6	the stationary frame
7	the intermediate frame

8 mounting plane

9 mounting plane

10 mounting plane

11 support lever

12 support lever

13 support lever

14 support lever

15 joint

16 joint

17 joint

18 joint

19 joint

20 joint

21 joint

22 joint

23 the measuring shaft axis

24 the virtual mounting position

25 the virtual mounting position

26 rotary mounting

27 balancing plane

28 balancing plane

29 retaining device

30 electric motor

31 belt drive

32 extension arm

33 retaining plate

34 angle bracket

35 parallel plane

36 parallel plane

37 attaching plate

38 attaching plate

40 attaching plate

41 attaching plate

[Patent Claims]

1. Device for measuring forces that are generated by an unbalance of a rotor, with

- a measuring shaft (2) mounted in a pivot bearing (26) and rotating on its axis (23), to which the rotor (1) for measuring is attached, and
- a mounting (3) - displaying a force sensor (4, 5) - of the measuring shaft (2) on a stationary frame (6), wherein
- the mounting (3) has an intermediate frame (7) against which the measuring shaft (2) is supported in a bearing plane displaying a force sensor (4), characterized in that
- the intermediate frame (7) is supported on the stationary frame (6) via a further force sensor (5) and
- the measuring shaft (2) is supported on the intermediate frame (7) and the intermediate frame (7) is supported on the stationary frame (6) and each is furthermore supported in a virtual mounting position (24, 25) formed by support levers (11, 12, 13, 14).

2. Device according to claim 1, characterized in that the force sensors (4, 5) are arranged in mounting planes in the area of the rigid intermediate frame (7).

3. Device according to claim 1 or 2, characterized in that the force sensors (4, 5) are situated in a common mounting plane (8).

4. Device according to one of claims 1 through 3, characterized in that the intermediate frame (7) is mounted on the stationary frame (6) and the measuring shaft (2) is mounted on the intermediate frame (7) in such a way that the forces introduced into the force

sensors (4, 5) are situated in one plane and are oriented parallel, in particular coaxially toward each other.

5. Device according to one of claims 1 through 4, characterized in that the virtual mounting positions (24, 25) are situated outside of the compensating planes (27, 28).

6. Device according to one of claims 1 through 5, characterized in that the virtual mounting positions (24, 25) form virtual measuring locations in their interfaces with the measuring shaft (2).

7. Device according to one of claims 1 through 6, characterized in that the virtual mounting positions (24, 25) are designed linearly and perpendicular to the measuring shaft axis (23).

8. Device according to claim 1 through 7, characterized in that the measuring shaft (2) is supported on the intermediate frame (7) in a second mounting plane (9) that displays the virtual mounting position (24) formed by the support levers (13, 14) and the intermediate frame (7) is supported in the mounting plane (8) displaying the force sensor (5) and with parallel guiding on the stationary frame (6).

9. Device according to one of claims 1 through 8, characterized in that the mounting (3) has only one virtual mounting position (24)).

10. Device according to one of claims 1 through 9, characterized in that the one virtual mounting position (24) is situated between the compensating planes (27, 28).

11. Device according to one of claims 1 through 9, characterized in that the one virtual mounting position (24) is situated between the rotor (1) and the stationary frame (6).

12. Device according to one of claims 1 through 7, characterized in that two virtual mounting positions (24, 25) are provided on both sides of the rotor (1).

13. Device according to one of claims 1 through 12, characterized in that one virtual mounting position (24) is situated roughly in the middle between the two compensating planes (27, 28).

14. Device according to one of claims 1 through 13, characterized in that the virtual mounting position (25) formed by a first pair of support levers (11, 12) is situated in an extension of the measuring shaft (2), which runs - with respect to the mounting (3) of the mounting shaft (2) - opposite to the longitudinal direction of the measuring shaft (2).

15. Device according to one of claims 1 through 14, characterized in that the mounting positions (24, 25) are situated at intersections of the extensions of the support levers (11, 12 / 13, 14) of the respective pair of support levers.

16. Device according to one of claims 1 through 15, characterized in that the intermediate frame (7) is supported via a first pair of support levers (11, 12) and joints (15 - 18) on

the stationary frame (6) and the measuring shaft (2) is supported via a second pair of support levers (13, 14) and joints (19 - 22) on the intermediate frame (7) and that the axes of the respective joints (15 - 22) run essentially perpendicular to the direction in which the forces introduced into the force sensors (4, 5) are effective and perpendicular to the axis (23) of the measuring shaft (2).

17. Device according to claim 16, characterized in that the support levers (11, 12) of the first pair of support levers are arranged parallel or at an angle the apex of which is situated essentially in the axis (23) of the measuring shaft (2).

18. Device according to claim 16 or 17, characterized in that the support levers (11 - 14) are formed by rigid flat parts that are arranged between the associated joints (15 - 22).

19. Device according to one of claims 16 through 18, characterized in that the flat parts forming the support levers (11 - 14) are situated with their surfaces in the same plane as the axes of the associated joints (15-22).

20. Device according to one of claims 16 through 19, characterized in that the support levers (11 through 14) and the joints (15 through 22) are formed from one piece, and the joints (15 through 22) are designed as weak points running linearly.

21. Device according to one of claims 1 through 20, characterized in that at least one of the two virtual mounting positions (24, 25) is offset relative to the axis (23) of the measuring shaft (2) toward the side on which the respectively associated force sensor (4, 5) is situated.

22. Device according to one of claims 1 through 21, characterized in that the support of the measuring shaft (2) in the intermediate frame (7) and the support of the intermediate frame (7) on the stationary frame (6) are situated - when observed in the axial direction of the measuring shaft (2) - one behind the other or next to each other.

23. Device according to one of claims 1 through 22, characterized in that the pivoting mounting (26) is solidly connected with a rigid holder (29) in the axial distance from the mounting plane (8) in which the force sensors (5, 6) are situated and that the holder (29) is supported via two support levers (13, 14) arranged at an angle to each other and the joint (19 through 22) is supported against the intermediate frame (8).

24. Device according to one of claims 1 through 23, characterized in that the weak points forming the joints (15 - 22) have a concave cross-section.

25. Device according to one of claims 1 through 23, characterized in that the weak points forming the joints (15 -22) are designed as linear perforations.

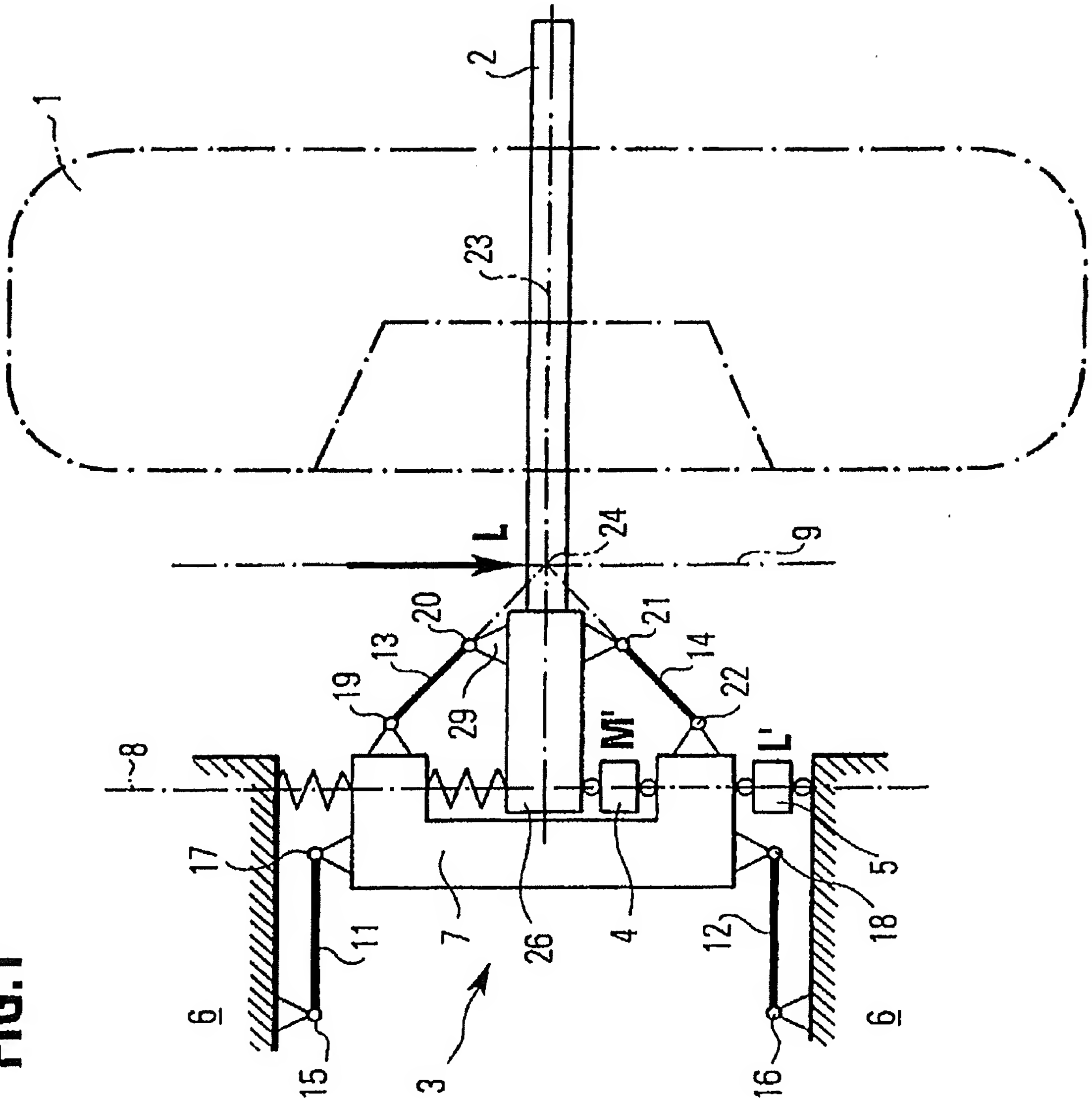


FIG.1

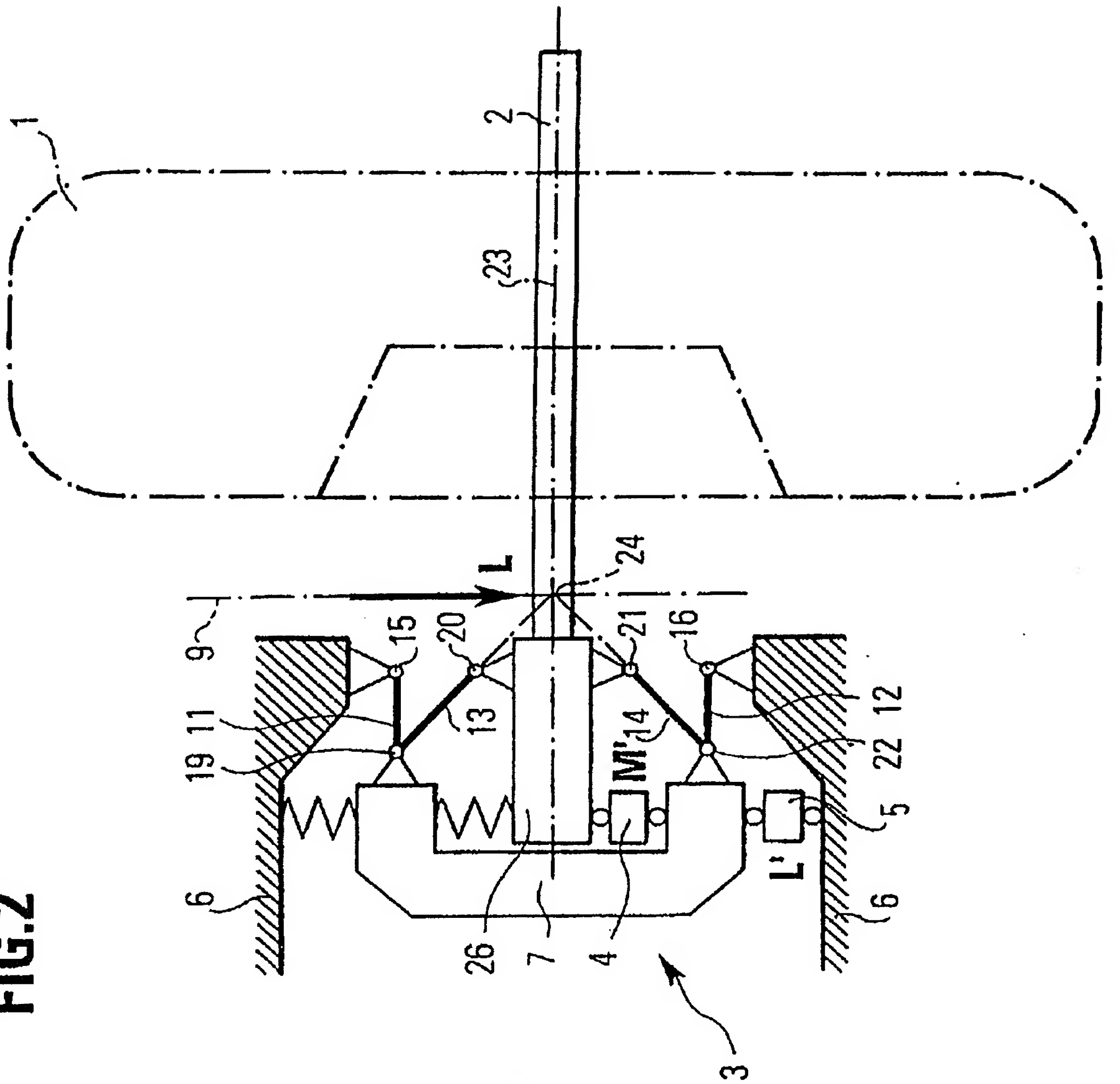


FIG.2

FIG.3

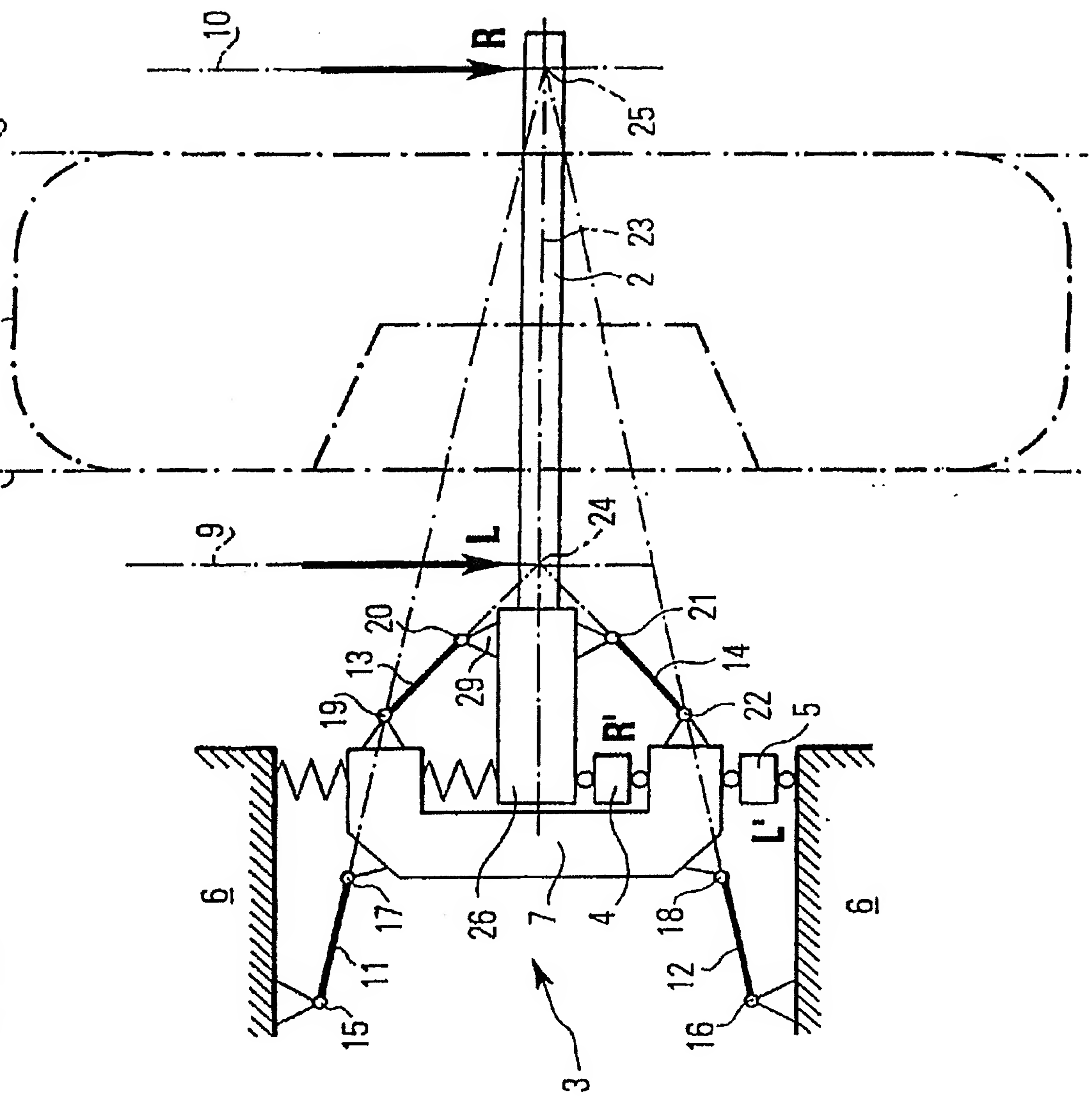

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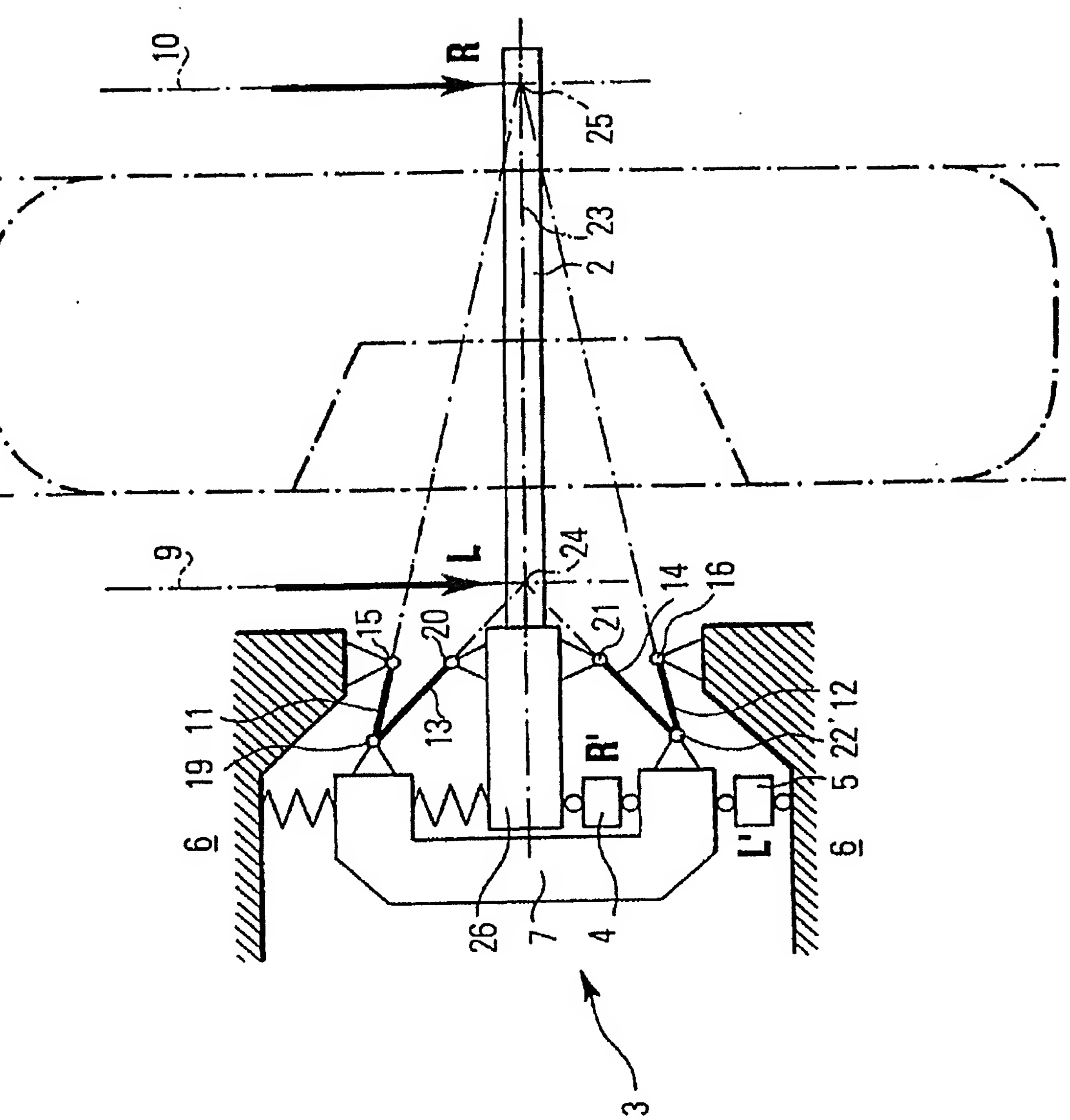
FIG.4



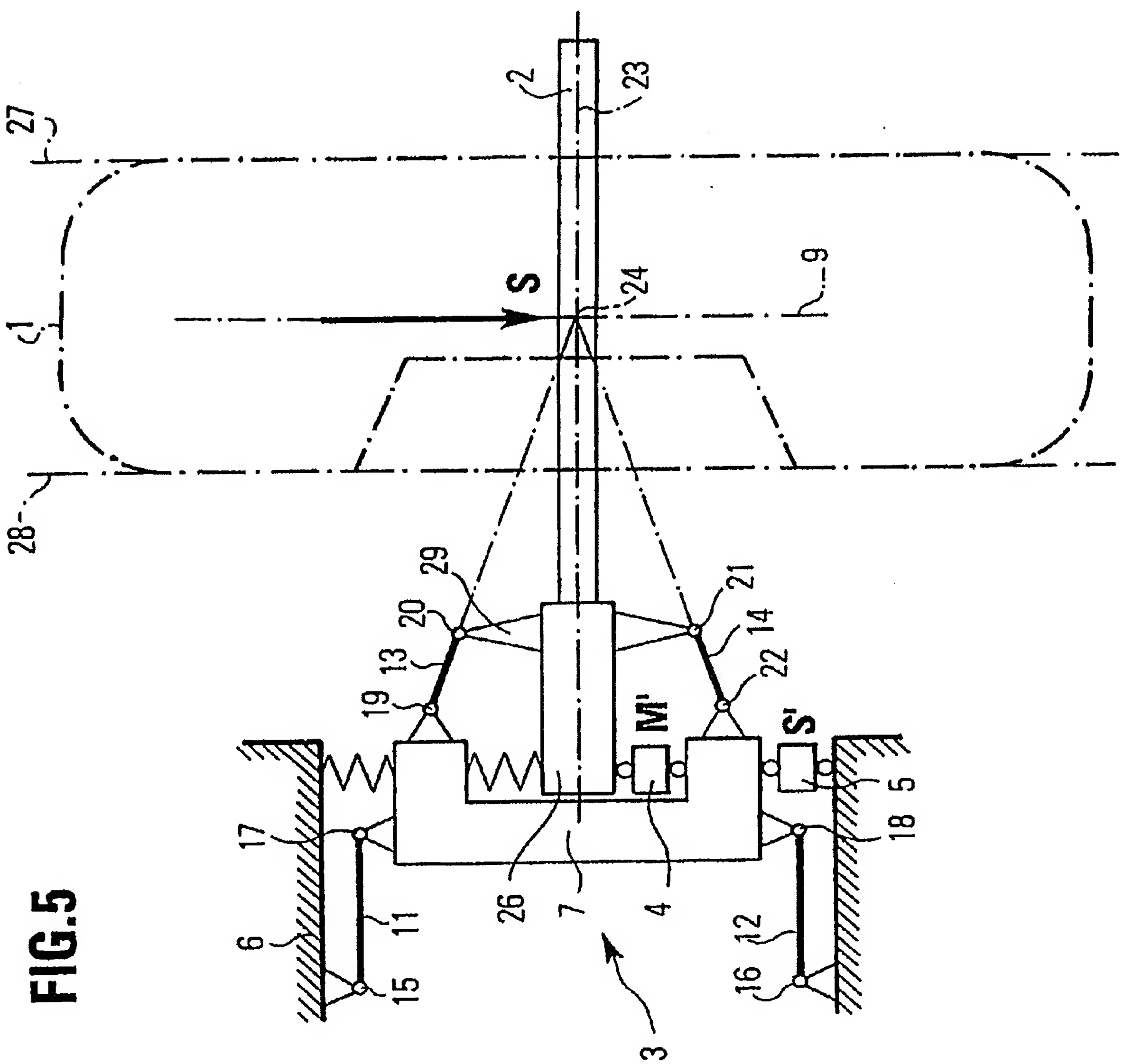


FIG.5

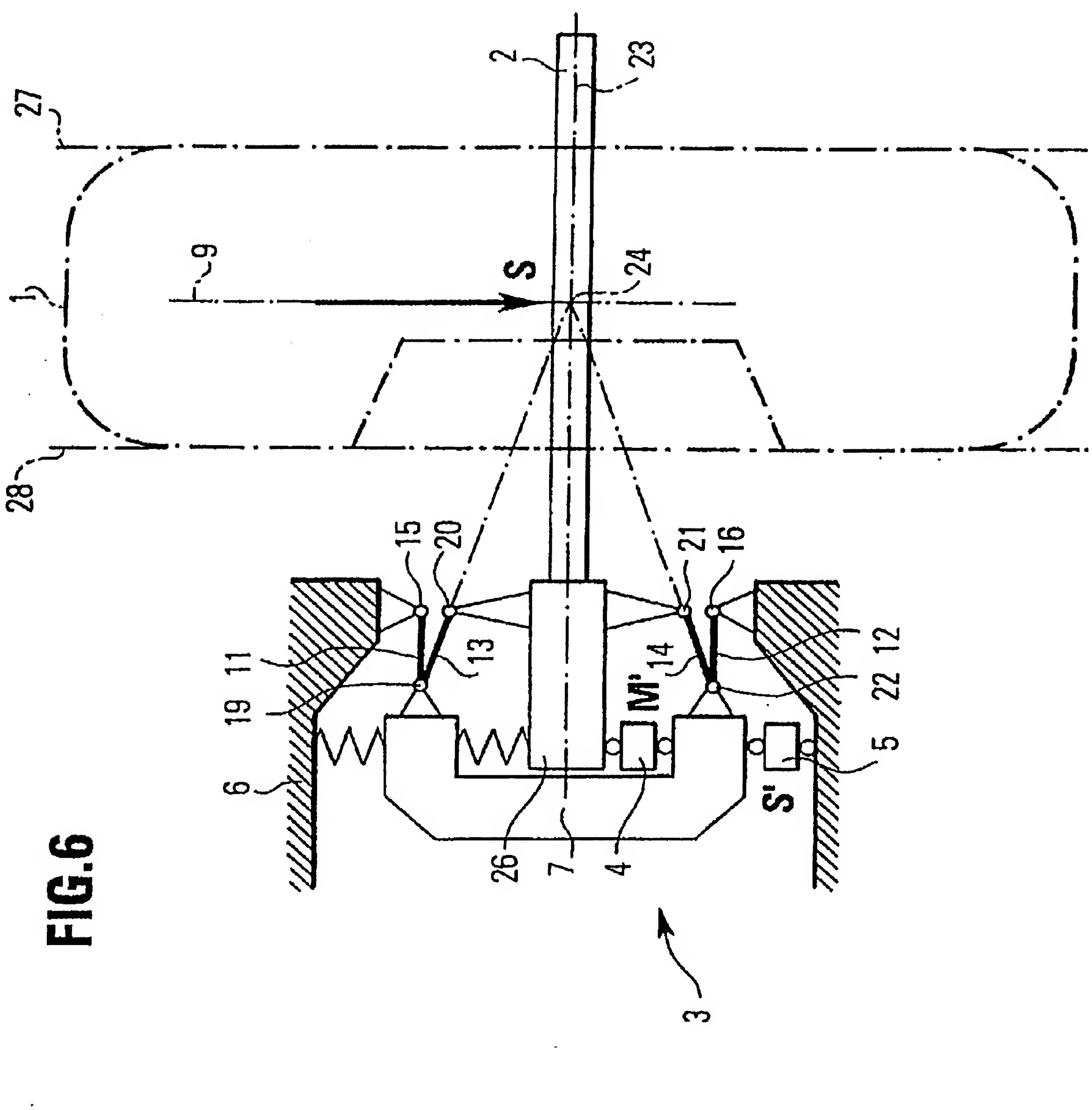


FIG.6

FIG.7

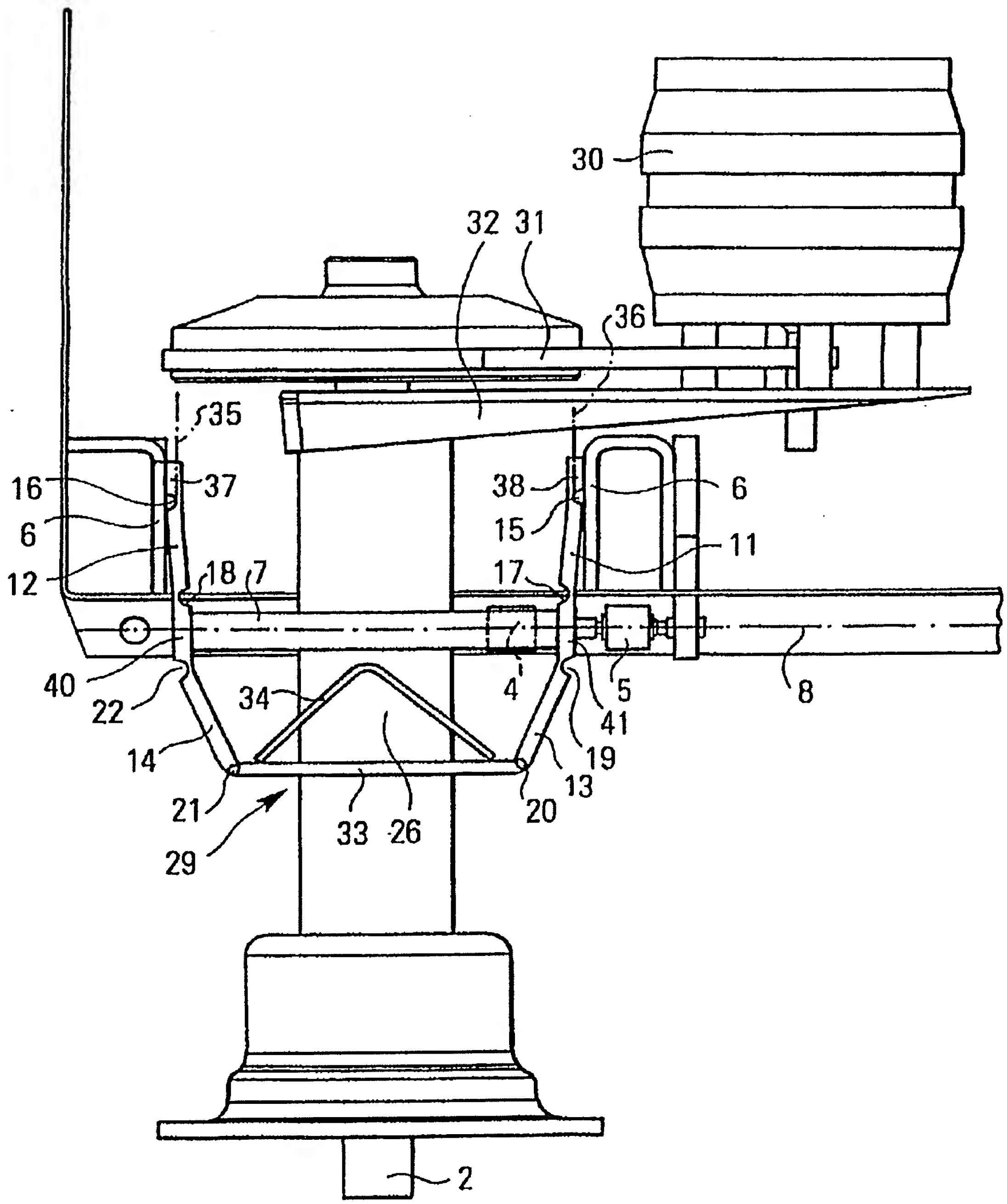

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FIG.8

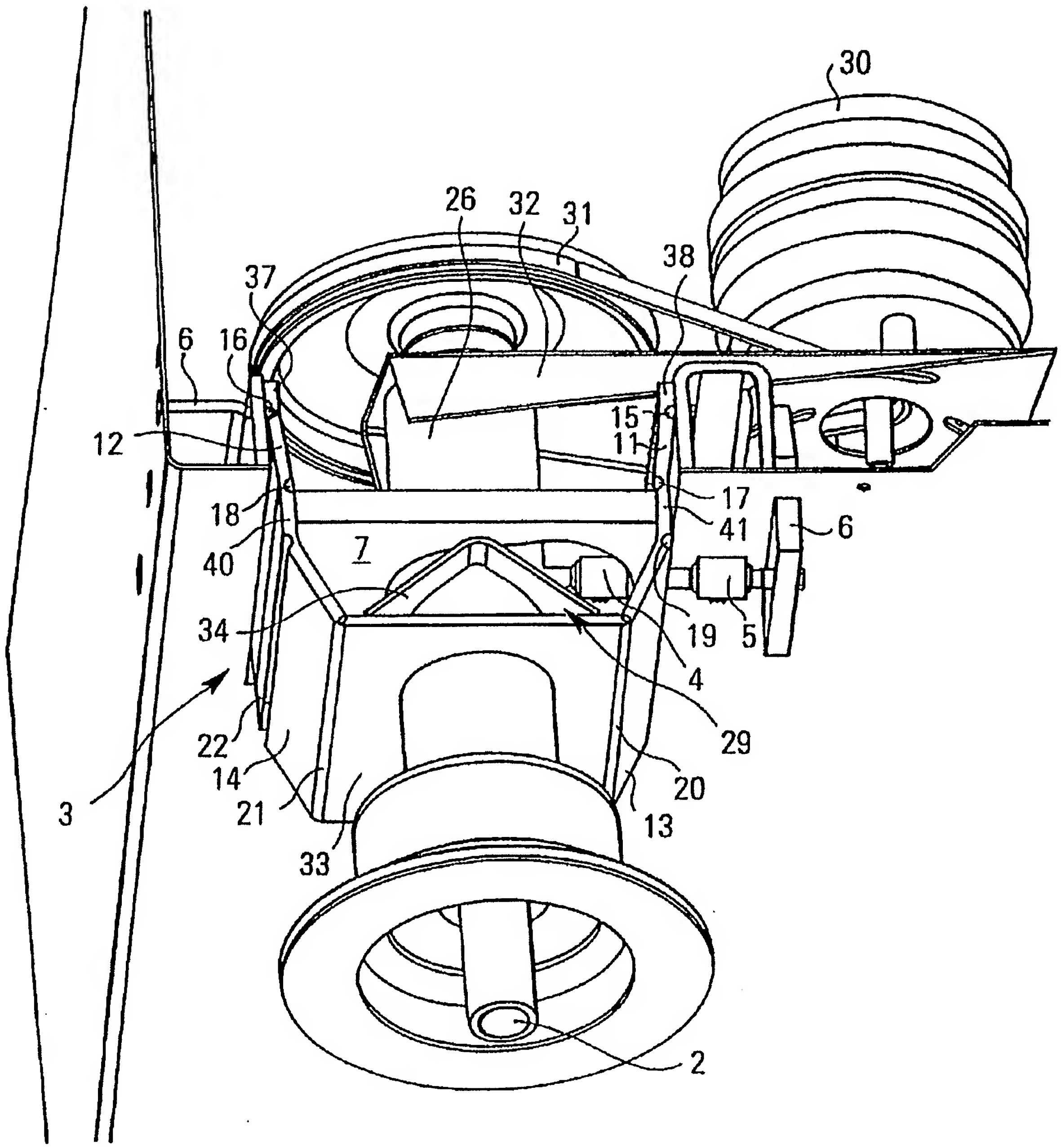
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FIG.9

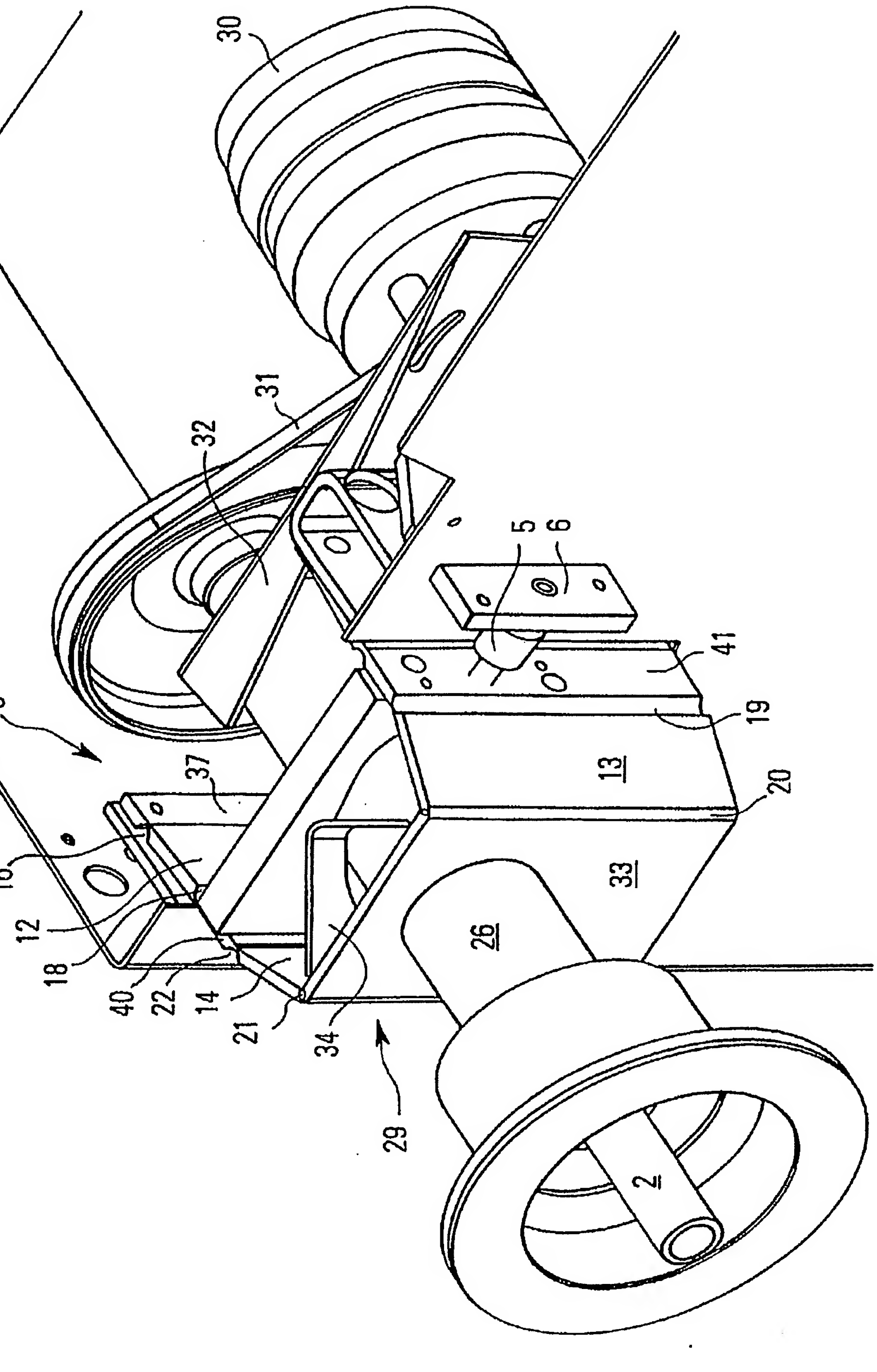

Fig. 10